

## PATENT ABSTRACTS OF JAPAN

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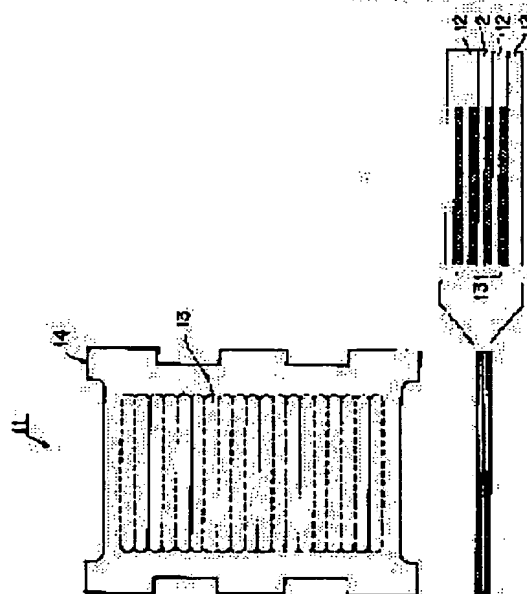
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YOSHIDA TOSHIHIKO**(54) MOVABLE COIL FOR LINEAR MOTOR, AND MOTOR HAVING MOVABLE COIL OF MULTILAYER CONSTRUCTION****(57)Abstract:****PROBLEM TO BE SOLVED:** To enhance heat radiating effect of the movable coil of a linear motor.**SOLUTION:** The movable coil 1 is made up of a multilayered board 14 of four layers, and a plurality of coils 13 among of spiral conductor patterns are formed in parallel on each layer. The coils 13 of each layer and electrically connected through insulating layers 12 through the use of through-holes.

第1の実施の形態の可動コイルの構造を示す図

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CLAIMS

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[Claim(s)]

[Claim 1] The moving coil of the linear motor which carries out the laminating of the conductor layer and insulating layer in which the coil which consists of a wound conductor pattern was formed, and is characterized by connecting the coil of two or more conductor layers electrically.

[Claim 2] The moving coil of the linear motor according to claim 1 characterized by consisting of even conductor layers and connecting electrically the inner circumference edge of the coil of the inner circumference edge of the coil of the top layer and the lowest layer or the top layer and the lowest layer, and an interlayer through an insulating layer.

[Claim 3] The moving coil of the linear motor according to claim 1 or 2 characterized by consisting of a conductor layer of at least four or more layers, and the inner circumference edge of the coil of the top layer, an interlayer, and the lowest layer being electrically connected through an insulating layer, respectively, and enabling it to connect the periphery edge of the coil of the top layer and the lowest layer with other coils formed on the external input or the same substrate.

[Claim 4] The moving coil of the linear motor according to claim 1, 2, or 3 characterized by forming said coil on the same substrate at two or more juxtaposition.

[Claim 5] The motor which has the moving coil of multilayer structure which serves as a conductor layer of at least three or more layers in which the coil which consists of a wound conductor pattern was formed from the insulating layer more than two-layer at least, and by which the coil of two or more conductor layers was electrically connected with it through the insulating layer.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the motor which has the moving coil of a linear motor, and the moving coil of multilayer structure.

[0002]

[Description of the Prior Art] A linear motor arranges the coil wound around the movable side in the shape of flat to two or more juxtaposition, the coil and predetermined spacing are vacated for a fixed side, a permanent magnet is arranged to juxtaposition, and rectilinear motion is performed by supplying alternating current to a coil.

[0003] What arranged to juxtaposition the coil which wound the wire rod around JP,2000-92812,A in the shape of flat, and formed it in it as an example of the structure of the coil of a movable side on the base plate is indicated.

[0004] This invention cuts and lacks the center section of the base plate which carries a coil, in order to heighten the heat dissipation effectiveness of a coil.

[0005]

[Problem(s) to be Solved by the Invention] However, since the above-mentioned invention also rolled the wire rod and the coil was created, it was difficult to carry out stripping of the generation of heat inside the coil when passing a current, and in order to suppress the temperature rise of a coil, the current passed in a coil needed to be restricted.

[0006] Moreover, the coil around which the wire rod was wound had heavy weight, and the effectiveness of a motor also had the trouble of carrying out a part fall. The technical problem of this invention is heightening the heat dissipation effectiveness of the moving coil of a linear motor. Other technical problems are lightweight-izing the moving coil of a motor.

[0007]

[Means for Solving the Problem] The moving coil of the linear motor of invention according to claim 1 carries out the laminating of the conductor layer and insulating layer in which the coil which consists of a wound conductor pattern was formed, and it constitutes them so that the coil of two or more conductor layers may be connected electrically.

[0008] Since heat is radiated from the coil formed in each conductor layer, respectively according to this invention, the heat sinking plane product of a coil can become large, and can carry out stripping of the heat generated in a coil efficiently. Moreover, by raising heat dissipation effectiveness, since the allowable-current consistency of a conductor pattern can be enlarged, the amount of the copper used for a moving coil can be reduced. Thereby, a moving coil is lightweight-ized and the effectiveness of a linear motor can be improved.

[0009] Furthermore, since a moving coil can be manufactured according to the manufacture process of a multilayer substrate, a production process can be simplified compared with the conventional manufacture approach which fixes to an adapter plate the coil rolled flatly.

[0010] In the above-mentioned invention, it may consist of even conductor layers and the inner circumference edge of the coil of the inner circumference edge of the coil of the top layer and the lowest layer or the top layer, an interlayer and the lowest layer, and an interlayer may be electrically connected through an insulating layer.

[0011] Thus, by constituting, the coil of a desired number of turns is realizable by connecting electrically the inner circumference edge of the coil of two or more conductor layers. It consists of a conductor layer of at least four or more layers, the inner circumference edge of the coil of the top layer, an interlayer, and the lowest layer is electrically connected through an insulating layer, respectively, and the periphery edge of the coil of the top layer and the lowest layer may enable it to connect with the periphery edge of other coils formed on the external input or the same substrate in the above-mentioned invention.

[0012] Thus, the coil formed on the same substrate with constituting is connectable on the same substrate. The motor of invention according to claim 6 serves as a conductor layer of at least three or more layers in which the coil which consists of a wound conductor pattern was formed from the insulating layer more than two-layer at least, and it has the moving coil of multilayer structure to which the coil of two or more conductor layers was electrically connected through the insulating layer.

[0013] According to this invention, by making a moving coil into multilayer structure, the heat sinking plane product of a conductor pattern can be enlarged, and the exoergic effectiveness of a moving coil can be heightened. Moreover, a moving coil can be lightweight-ized with constituting from a multilayer substrate, and, thereby, the effectiveness of a motor can also be improved.

[0014]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained, referring to a drawing. Drawing 1 is drawing showing the structure of the moving coil 11 of the linear motor of the gestalt of the 1st operation.

[0015] This moving coil 11 consists of a multilayer substrate 14 with which the printed coil 13 was formed of etching on the insulating layers 12, such as glass epoxy. The pattern is formed in the curled form and the printed coil 13 is formed on the insulating layer 12 at two or more juxtaposition.

[0016] A moving coil 11 consists of five layers in which a conductor layer contains four layers in and an insulating layer also contains the resist of the top layer, and the printed coil 13 is formed on the insulating layer 12 of the 4th layer from the 1st layer.

[0017] Drawing 2 is the explanatory view of the connection method between the layers of the moving coil 11 of multilayer structure. If a linear motor is a three-phase-circuit alternating current motor, it will be electrically connected with other printed coils 13 of the same phase, among those as for the periphery edge 21 of the printed coil 13 which consists of a wound conductor pattern of the 1st layer (the top layer), the through hole 23 is formed in the peripheral edge section 22.

[0018] A through hole 25 is formed in the inner circumference edge 24 of the curled form printed coil 13 of the 2nd layer (interlayer), and the through hole 27 is formed also in the periphery edge 26. The through hole 25 of the inner circumference edge 24 of the printed coil 13 of the 2nd layer penetrates the insulating layer 12 between the 1st layer and the 2nd layer, and is electrically connected with the through hole 23 of the inner circumference edge 22 of the printed coil 13 of the 1st layer. Thereby, the printed coil 13 of the 2nd layer and the printed coil 13 of the 1st layer are connected to a serial.

[0019] A through hole 29 is formed in the periphery edge 28 of the curled form printed coil 13 of the 3rd layer, and the through hole 31 is formed in the inner circumference edge 30. The through hole 29 of the periphery edge 28 of the 3rd layer penetrates the insulating layer 12 between the 3rd layer and the 2nd layer, and is electrically connected with the through hole 27 of the 2nd layer. In addition, the through hole 31 of the 3rd layer is insulated with the through hole 25 of the 2nd layer, and the printed coil of the 2nd layer.

[0020] Thereby, the printed coil 13 of the 3rd layer and the printed coil 13 of the 2nd layer are connected to a serial. The through hole 33 is formed in the inner circumference edge 32 of the curled form printed coil 13 of the 4th layer. This through hole 33 penetrates the insulating layer 12 between the 4th layer and the 3rd layer, and is electrically connected with the through hole 31 of the inner circumference edge 30 of the 3rd layer. Thereby, the printed coil 13 of the 4th layer and the printed coil 13 of the 3rd layer are connected to a serial.

[0021] The periphery edge 34 of the printed coil 13 of the 4th layer (the lowest layer) is connected to other printed coils 13 formed on the same substrate. Namely, the inner circumference edge 22 of the printed coil 13 of the 1st layer is connected to the inner circumference edge 24 of the printed coil 13 of the 2nd layer. The periphery edge 26 of the printed coil 13 of the 2nd layer is connected to the periphery edge 28 of the printed coil 13 of the 3rd layer, further, the inner circumference edge 30 of the 3rd layer is connected to the inner circumference edge 32 of the printed coil 13 of the 4th layer, and four printed coils 13 are connected to a serial as a whole.

[0022] Therefore, if the number of turns of the printed coil 13 per layer are set to  $n$ , the number of turns of the moving-coil 11 whole in four layers are set to  $4n$ , and desired number of turns can be obtained by increasing a number of layers.

[0023] Next, drawing 3 is the explanatory view of the connection method of the printed coil in the case of using a three-phase-alternating-current motor as a linear motor. two or more printed coils [ substrate / 14 / multilayer ] 41, 49, and 61 .. forms in juxtaposition — having — \*\*\*\* — each printed coils 41, 49, and 61 .. is connected by the three-phase-circuit Y connection — having — printed coils 41, 49, and 61 — the three-phase-circuit alternating current of U phase, V phase, and W phase is supplied to .. in order.

[0024] In drawing 3, the arrow head of a broken line shows the conductor pattern of the 4th layer for the conductor pattern of the 1st layer to which the arrow head of a continuous line connects a printed coil. Connection of the printed coil of U phase is explained first. The periphery edge 42 of the printed coil 41 of the 1st layer of U phase is connected with other printed coils of U phase formed on the same substrate, or the current of U phase of a three-phase-circuit alternating current is supplied from the outside. And the periphery edge 43 of the printed coil 41 of the 4th layer is connected by the following periphery edge 45 and following conductor pattern of the printed coil 44 of the 4th layer of U phase. Furthermore, the periphery edge 46 of the printed coil 44 of the 1st layer of U phase is connected with the periphery edge 48 of the printed coil 47 of the 1st layer of the following U phase.

[0025] Therefore, the current of U phase supplied to the periphery edge 42 of the printed coil 41 of the 1st layer of U phase flows to the printed coil 41 of the 2nd layer through the through hole of an inner circumference edge, and flows to the printed coil 41 of the 3rd layer through the through hole of the periphery edge of the printed coil 41 of the 2nd layer. Furthermore, it flows to the printed coil 41 of the 4th layer through the through hole of the inner circumference edge of the printed coil 41 of the 3rd layer, and flows from the periphery edge 43 of the printed coil 41 of the 4th layer to the printed coil 44 of the 4th layer as follows of U layers. The current which flowed into the printed coil 44 of the 4th layer flows from the periphery edge 46 of the 1st layer to the printed coil 47 of the 1st layer of the following U phase through the printed coil 44 of the 3rd layer, the 2nd layer, and the 1st layer.

[0026] Next, the current of V phase of the three-phase alternating current is supplied to the periphery edge 50 of the printed coil 49 of the 4th layer of V phase from other printed coils or exteriors which were formed on the same substrate. The periphery edge 51 of the printed coil 49 of the 1st layer of V phase is connected by the following periphery edge 53 and following conductor pattern of the printed coil 52 of the 1st layer of V phase. In addition, since this conductor pattern intersects the conductor pattern of U phase mentioned above, the part is connected by the conductor pattern of the 3rd layer through the through hole 54. The periphery edge 55 of the printed coil 52 of the 4th layer of V phase is connected by the following periphery edge 57 and following conductor pattern of the 4th-layer print 56 of V phase. The periphery edge 58 of the printed coil 56 of the 1st layer of the V phase is connected with the periphery edge 60 of the printed coil 47 of the 4th layer of U phase, and the periphery edge 69 of the printed coil 67 of the 4th layer of W layers by the conductor pattern through the through hole 59.

[0027] Therefore, the current supplied to the periphery edge 50 of the printed coil 49 of the 4th layer of V phase flows to the printed coil 49 of the 3rd layer through the through hole of an inner circumference edge (not shown), and flows to the printed coil 49 of the 2nd layer through the through hole of the periphery edge of the printed coil 49 of the 3rd layer. Furthermore, it flows to the printed coil 49 of the 1st layer through the through hole of the inner circumference edge of

the printed coil 49 of the 2nd layer, and flows from the periphery edge 51 of the printed coil 49 of the 1st layer to the printed coil 52 of the 1st layer of the following V phase. The current which flowed into the printed coil 52 of this V phase flows from the periphery edge 55 of the printed coil 52 of the 4th layer to the printed coil 56 of the 4th layer of the following V phase through the printed coil 52 of the 2nd layer, the 3rd layer, and the 4th layer.

[0028] Next, other printed coils formed on the same substrate are connected to the periphery edge 62 of the printed coil 61 of the 1st layer of W phase, or the current of W phase of a three-phase-circuit alternating current is supplied to it from the outside. This printed coil 61 of the 1st layer is connected with the printed coil 61 of the 2nd layer, the 3rd layer, and the 4th layer through the through hole at the serial.

[0029] The periphery edge 63 of the printed coil 61 of the 4th layer is connected by the following periphery edge 65 and following conductor pattern of the printed coil 64 of the 4th layer of W phase. Furthermore, the periphery edge 66 of the printed coil 64 of the 1st layer of W phase and the periphery edge 68 of the printed coil 67 of the 1st layer of the following W phase are connected by the conductor pattern. The periphery edge 69 of the printed coil 67 of the 1st layer of the W phase is connected by the periphery edge 60 of the printed coil 47 of the 4th layer of U phase and the periphery edge 58 of the printed coil 56 of the 4th phase of V phase, and the conductor pattern.

[0030] Therefore, the current supplied to the printed coil 61 of the 1st layer of W layers flows the printed coil 61 of the 2nd layer, the 3rd layer, and the 4th layer. And it flows from the periphery edge 61 of the printed coil 61 of the 4th layer to the printed coil 64 of the 4th layer as follows of W layers.

[0031] According to the gestalt of operation mentioned above, the surface area of the conductor pattern section which serves as a current path compared with the conventional copper coil with constituting the moving coil 11 of a linear motor by the printed circuit board of multilayer structure can be doubled [ about / more than ]. Thereby, since the heat dissipation effectiveness of the conductor pattern of a current path can be raised, compared with a copper coil, a current can be passed by one about 5 times the current density of this. Furthermore, since current density can increase, the amount of copper [ used ] is reduced and-izing of the moving coil 11 can be carried out [ lightweight ].

[0032] Next, drawing 4 (A) and (B) are the flat surfaces and important section sectional views of a moving coil 71 by the side of the rotator of the rotary motor of the gestalt of operation of the 2nd of this invention. The moving coil 71 of the gestalt of this 2nd operation consists of multilayer printed boards which consist of a conductor layer which consists of an insulating layer 73 of four layers, printed coils 72b and 76a, etc., as shown in drawing 4 (B), and the conductor layer of the 1st layer is covered with the resist. Moreover, the revolving shaft 91 is being fixed to the center section of the moving coil 71 by press fit, adhesion, and the other mechanical fixed approaches.

[0033] As shown in drawing 4 (A), two printed coils with which the current of U phase of a three-phase-circuit alternating current, V phase, and W phase flows are formed in each class of etching etc., respectively. Two printed coils 72a and 72b of U phase of the 1st layer are formed on the insulating layer 73 of the 1st layer, and printed coil 72a and printed coil 72b are connected to the serial by the conductor pattern 75.

[0034] As for two printed coils 72a and 72b, each inner circumference edge is connected with the inner circumference edge of the printed coils 72a and 72b of the 2nd layer through through holes 74a and 74b. Furthermore, the periphery edge of the printed coils 72a and 72b of the 2nd layer is connected to the periphery edge of the printed coils 72a and 72b of the 3rd layer through a through hole, and the inner circumference edge of the printed coils 72a and 72b of the 3rd layer is connected with the inner circumference edge of the printed coils 72a and 72b of the 4th layer through the through hole.

[0035] Therefore, the current of U phase supplied to the periphery terminal 80 of printed coil 72a of the 4th layer flows printed coil of 3rd layer, 2nd layer, and 1st layer 72a, passes along a conductor pattern 75, flows to printed coil of 1st layer 72b, and flows further to printed coil of 2nd layer, 3rd layer, and 4th layer 72b.

[0036] The printed coils 76a and 76b of the 1st layer to the 4th layer are connected to the serial also for V phase by the through hole, and two printed coils 76a and 76b of V phase of the 1st layer are connected to the serial by through holes 77a and 77b and the conductor pattern (a broken line shows to drawing 4) of the 2nd layer. Moreover, the current of V phase of the three-phase alternating current is supplied to the periphery edge of printed coil 76a of V phase of the 4th layer.

[0037] Therefore, the current of U phase supplied to the periphery terminal 81 of printed coil 76a of the 4th layer flows printed coil of 3rd layer, 2nd layer, and 1st layer 76a, passes along the conductor pattern of the 2nd layer, and flows to printed coil of 1st layer 76b. Furthermore, it flows to printed coil of 2nd layer, 3rd layer, and 4th layer 76b.

[0038] The printed coils 78a and 78b of each phase are connected to the serial also for W phase by the through hole, and the printed coils 78a and 78b of W phase of the 1st layer are connected to the serial by the conductor pattern of the 1st layer, through holes 79a and 79b, and the conductor pattern (a broken line shows to drawing 4) of the 2nd layer. Moreover, the current of W phase of the three-phase alternating current is supplied to the periphery edge of printed coil 78a of W phase of the 4th layer.

[0039] Furthermore, the periphery edge of the printed coils 72b, 76b, and 78b of U layers, V layers, and W layers of the 4th layer is mutually connected by the conductor pattern. According to the gestalt of this 2nd operation, since a multilayer printed board can constitute the moving coil of a rotary motor, compared with the rotator of a coil, a miniaturization and lightweight-ization are attained, the effectiveness of a motor can also be improved by that cause, and it comes out. Moreover, since a moving coil can be manufactured according to the manufacture process of a multilayer substrate, it becomes possible to reduce a manufacturing cost by automation.

[0040] Although it enabled it to connect the periphery edge of two or more printed coils in the same field top as the field which was mentioned above and in which the conductor layer was made into even number (for example, four layers), and the printed coil was formed with a conductor pattern with the gestalt of the 1st operation, a conductor layer can also be made into odd number when a conductor pattern may be pulled out from the inner circumference edge of a printed coil using a through hole etc.

[0041] Ingredients, such as plastics of not only the glass epoxy group plate of the gestalt of operation but others and a ceramic, can be used for a multilayer substrate. Moreover, the approach of forming a conductor pattern not only by the approach of forming a conductor pattern by etching but by electroplating, chemical plating, etc., the approach of forming a conductor pattern by vacuum evaporation, etc. are sufficient as the manufacture approach of a multilayer substrate.

[0042] Furthermore, the beer which buried the through tube of not only an approach but the insulating layer which uses a through hole by electrolytic plating etc. may be used for the approach of connecting an up-and-down conductor layer through an insulating layer, and you may make it connect it electrically by the other approaches.

[0043] In addition, although it explained the case where a moving coil was constituted from one multilayer substrate, the gestalt of operation mentioned above forms a printed coil in two or more multilayer substrates, respectively, may fix to an adapter plate at one, and may operate the multilayer substrate of these plurality as one moving coil as a whole. When the dimension of a moving coil is large, the cost of a multilayer substrate can be held down by using the multilayer substrate of general-purpose size.

[0044]

[Effect of the Invention] According to this invention, the heat sinking plane product of the conductor pattern with which a current flows compared with the conventional moving coil which carried out the lap winding of the wire rod can be enlarged, and the heat dissipation effectiveness can be heightened. Moreover, since the allowable-current consistency of a conductor pattern can be enlarged by heightening the heat dissipation effectiveness, in order to obtain a desired motor output, the amount of the copper used for a moving coil can be reduced. Thereby, a moving coil is lightweight-ized and the effectiveness of a motor can be improved.

Moreover, since a moving coil can be manufactured in the manufacture process of a multilayer substrate, a manufacturing cost can be reduced by automation. Furthermore, the periphery edge of the coil of the top layer and the lowest layer is connectable with the periphery edge of other direct coils by connecting the inner circumference edge of the coil of the top layer and the lowest layer through a middle conductor layer and a middle insulating layer through an insulating layer. Connection between a coil and an external input or connection of coils which consists of a conductor pattern can be made by this on the same field as the field in which the coil is formed, numbers, such as a through hole for connecting a coil, are lessened, and a manufacturing cost can be reduced.

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**TECHNICAL FIELD**

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[Field of the Invention] This invention relates to the motor which has the moving coil of a linear motor, and the moving coil of multilayer structure.

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**PRIOR ART**

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[Description of the Prior Art] A linear motor arranges the coil wound around the movable side in the shape of flat to two or more juxtaposition, the coil and predetermined spacing are vacated for a fixed side, a permanent magnet is arranged to juxtaposition, and rectilinear motion is performed by supplying alternating current to a coil.

[0003] What arranged to juxtaposition the coil which wound the wire rod around JP,2000-92812,A in the shape of flat, and formed it in it as an example of the structure of the coil of a movable side on the base plate is indicated.

[0004] This invention cuts and lacks the center section of the base plate which carries a coil, in order to heighten the heat dissipation effectiveness of a coil.

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**EFFECT OF THE INVENTION**

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[Effect of the Invention] According to this invention, the heat sinking plane product of the conductor pattern with which a current flows compared with the conventional moving coil which carried out the lap winding of the wire rod can be enlarged, and the heat dissipation effectiveness can be heightened. Moreover, since the allowable-current consistency of a conductor pattern can be enlarged by heightening the heat dissipation effectiveness, in order to obtain a desired motor output, the amount of the copper used for a moving coil can be reduced. Thereby, a moving coil is lightweight-ized and the effectiveness of a motor can be improved. Moreover, since a moving coil can be manufactured in the manufacture process of a multilayer substrate, a manufacturing cost can be reduced by automation. Furthermore, the periphery edge of the coil of the top layer and the lowest layer is connectable with the periphery edge of other direct coils by connecting the inner circumference edge of the coil of the top layer and the lowest layer through a middle conductor layer and a middle insulating layer through an insulating layer. Connection between a coil and an external input or connection of coils which consists of a conductor pattern can be made by this on the same field as the field in which the coil is formed, numbers, such as a through hole for connecting a coil, are lessened, and a manufacturing cost can be reduced.

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**TECHNICAL PROBLEM**

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[Problem(s) to be Solved by the Invention] However, since the above-mentioned invention also rolled the wire rod and the coil was created, it was difficult to carry out stripping of the generation of heat inside the coil when passing a current, and in order to suppress the temperature rise of a coil, the current passed in a coil needed to be restricted.

[0006] Moreover, the coil around which the wire rod was wound had heavy weight, and the effectiveness of a motor also had the trouble of carrying out a part fall. The technical problem of this invention is heightening the heat dissipation effectiveness of the moving coil of a linear motor. Other technical problems are lightweight-izing the moving coil of a motor.

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MEANS

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[Means for Solving the Problem] The moving coil of the linear motor of invention according to claim 1 carries out the laminating of the conductor layer and insulating layer in which the coil which consists of a wound conductor pattern was formed, and it constitutes them so that the coil of two or more conductor layers may be connected electrically.

[0008] Since heat is radiated from the coil formed in each conductor layer, respectively according to this invention, the heat sinking plane product of a coil can become large, and can carry out stripping of the heat generated in a coil efficiently. Moreover, by raising heat dissipation effectiveness, since the allowable-current consistency of a conductor pattern can be enlarged, the amount of the copper used for a moving coil can be reduced. Thereby, a moving coil is lightweight-ized and the effectiveness of a linear motor can be improved.

[0009] Furthermore, since a moving coil can be manufactured according to the manufacture process of a multilayer substrate, a production process can be simplified compared with the conventional manufacture approach which fixes to an adapter plate the coil rolled flatly.

[0010] In the above-mentioned invention, it may consist of even conductor layers and the inner circumference edge of the coil of the inner circumference edge of the coil of the top layer and the lowest layer or the top layer, an interlayer and the lowest layer, and an interlayer may be electrically connected through an insulating layer.

[0011] Thus, by constituting, the coil of a desired number of turns is realizable by connecting electrically the inner circumference edge of the coil of two or more conductor layers. It consists of a conductor layer of at least four or more layers, the inner circumference edge of the coil of the top layer, an interlayer, and the lowest layer is electrically connected through an insulating layer, respectively, and the periphery edge of the coil of the top layer and the lowest layer may enable it to connect with the periphery edge of other coils formed on the external input or the same substrate in the above-mentioned invention.

[0012] Thus, the coil formed on the same substrate with constituting is connectable on the same substrate. The motor of invention according to claim 6 serves as a conductor layer of at least three or more layers in which the coil which consists of a wound conductor pattern was formed from the insulating layer more than two-layer at least, and it has the moving coil of multilayer structure to which the coil of two or more conductor layers was electrically connected through the insulating layer.

[0013] According to this invention, by making a moving coil into multilayer structure, the heat sinking plane product of a conductor pattern can be enlarged, and the exoergic effectiveness of a moving coil can be heightened. Moreover, a moving coil can be lightweight-ized with constituting from a multilayer substrate, and, thereby, the effectiveness of a motor can also be improved.

[0014]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained, referring to a drawing. Drawing 1 is drawing showing the structure of the moving coil 11 of the linear motor of the gestalt of the 1st operation.

[0015] This moving coil 11 consists of a multilayer substrate 14 with which the printed coil 13 was formed of etching on the insulating layers 12, such as glass epoxy. The pattern is formed in

the curled form and the printed coil 13 is formed on the insulating layer 12 at two or more juxtaposition.

[0016] A moving coil 11 consists of five layers in which a conductor layer contains four layers in and an insulating layer also contains the resist of the top layer, and the printed coil 13 is formed on the insulating layer 12 of the 4th layer from the 1st layer.

[0017] Drawing 2 is the explanatory view of the connection method between the layers of the moving coil 11 of multilayer structure. If a linear motor is a three-phase-circuit alternating current motor, it will be electrically connected with other printed coils 13 of the same phase, among those as for the periphery edge 21 of the printed coil 13 which consists of a wound conductor pattern of the 1st layer (the top layer), the through hole 23 is formed in the peripheral edge section 22.

[0018] A through hole 25 is formed in the inner circumference edge 24 of the curled form printed coil 13 of the 2nd layer (interlayer), and the through hole 27 is formed also in the periphery edge 26. The through hole 25 of the inner circumference edge 24 of the printed coil 13 of the 2nd layer penetrates the insulating layer 12 between the 1st layer and the 2nd layer, and is electrically connected with the through hole 23 of the inner circumference edge 22 of the printed coil 13 of the 1st layer. Thereby, the printed coil 13 of the 2nd layer and the printed coil 13 of the 1st layer are connected to a serial.

[0019] A through hole 29 is formed in the periphery edge 28 of the curled form printed coil 13 of the 3rd layer, and the through hole 31 is formed in the inner circumference edge 30. The through hole 29 of the periphery edge 28 of the 3rd layer penetrates the insulating layer 12 between the 3rd layer and the 2nd layer, and is electrically connected with the through hole 27 of the 2nd layer. In addition, the through hole 31 of the 3rd layer is insulated with the through hole 25 of the 2nd layer, and the printed coil of the 2nd layer.

[0020] Thereby, the printed coil 13 of the 3rd layer and the printed coil 13 of the 2nd layer are connected to a serial. The through hole 33 is formed in the inner circumference edge 32 of the curled form printed coil 13 of the 4th layer. This through hole 33 penetrates the insulating layer 12 between the 4th layer and the 3rd layer, and is electrically connected with the through hole 31 of the inner circumference edge 30 of the 3rd layer. Thereby, the printed coil 13 of the 4th layer and the printed coil 13 of the 3rd layer are connected to a serial.

[0021] The periphery edge 34 of the printed coil 13 of the 4th layer (the lowest layer) is connected to other printed coils 13 formed on the same substrate. Namely, the inner circumference edge 22 of the printed coil 13 of the 1st layer is connected to the inner circumference edge 24 of the printed coil 13 of the 2nd layer. The periphery edge 26 of the printed coil 13 of the 2nd layer is connected to the periphery edge 28 of the printed coil 13 of the 3rd layer, further, the inner circumference edge 30 of the 3rd layer is connected to the inner circumference edge 32 of the printed coil 13 of the 4th layer, and four printed coils 13 are connected to a serial as a whole.

[0022] Therefore, if the number of turns of the printed coil 13 per layer are set to  $n$ , the number of turns of the moving-coil 11 whole in four layers are set to  $4n$ , and desired number of turns can be obtained by increasing a number of layers.

[0023] Next, drawing 3 is the explanatory view of the connection method of the printed coil in the case of using a three-phase-alternating-current motor as a linear motor. two or more printed coils [ substrate / 14 / multilayer ] 41, 49, and 61 .. forms in juxtaposition — having — \*\*\*\* — each printed coils 41, 49, and 61 .. is connected by the three-phase-circuit Y connection — having — printed coils 41, 49, and 61 — the three-phase-circuit alternating current of U phase, V phase, and W phase is supplied to .. in order.

[0024] In drawing 3, the arrow head of a broken line shows the conductor pattern of the 4th layer for the conductor pattern of the 1st layer to which the arrow head of a continuous line connects a printed coil. Connection of the printed coil of U phase is explained first. The periphery edge 42 of the printed coil 41 of the 1st layer of U phase is connected with other printed coils of U phase formed on the same substrate, or the current of U phase of a three-phase-circuit alternating current is supplied from the outside. And the periphery edge 43 of the printed coil 41 of the 4th layer is connected by the following periphery edge 45 and following

conductor pattern of the printed coil 44 of the 4th layer of U phase. Furthermore, the periphery edge 46 of the printed coil 44 of the 1st layer of U phase is connected with the periphery edge 48 of the printed coil 47 of the 1st layer of the following U phase.

[0025] Therefore, the current of U phase supplied to the periphery edge 42 of the printed coil 41 of the 1st layer of U phase flows to the printed coil 41 of the 2nd layer through the through hole of an inner circumference edge, and flows to the printed coil 41 of the 3rd layer through the through hole of the periphery edge of the printed coil 41 of the 2nd layer. Furthermore, it flows to the printed coil 41 of the 4th layer through the through hole of the inner circumference edge of the printed coil 41 of the 3rd layer, and flows from the periphery edge 43 of the printed coil 41 of the 4th layer to the printed coil 44 of the 4th layer as follows of U layers. The current which flowed into the printed coil 44 of the 4th layer flows from the periphery edge 46 of the 1st layer to the printed coil 47 of the 1st layer of the following U phase through the printed coil 44 of the 3rd layer, the 2nd layer, and the 1st layer.

[0026] Next, the current of V phase of the three-phase alternating current is supplied to the periphery edge 50 of the printed coil 49 of the 4th layer of V phase from other printed coils or exteriors which were formed on the same substrate. The periphery edge 51 of the printed coil 49 of the 1st layer of V phase is connected by the following periphery edge 53 and following conductor pattern of the printed coil 52 of the 1st layer of V phase. In addition, since this conductor pattern intersects the conductor pattern of U phase mentioned above, the part is connected by the conductor pattern of the 3rd layer through the through hole 54. The periphery edge 55 of the printed coil 52 of the 4th layer of V phase is connected by the following periphery edge 57 and following conductor pattern of the 4th-layer print 56 of V phase. The periphery edge 58 of the printed coil 56 of the 1st layer of the V phase is connected with the periphery edge 60 of the printed coil 47 of the 4th layer of U phase, and the periphery edge 69 of the printed coil 67 of the 4th layer of W layers by the conductor pattern through the through hole 59.

[0027] Therefore, the current supplied to the periphery edge 50 of the printed coil 49 of the 4th layer of V phase flows to the printed coil 49 of the 3rd layer through the through hole of an inner circumference edge (not shown), and flows to the printed coil 49 of the 2nd layer through the through hole of the periphery edge of the printed coil 49 of the 3rd layer. Furthermore, it flows to the printed coil 49 of the 1st layer through the through hole of the inner circumference edge of the printed coil 49 of the 2nd layer, and flows from the periphery edge 51 of the printed coil 49 of the 1st layer to the printed coil 52 of the 1st layer of the following V phase. The current which flowed into the printed coil 52 of this V phase flows from the periphery edge 55 of the printed coil 52 of the 4th layer to the printed coil 56 of the 4th layer of the following V phase through the printed coil 52 of the 2nd layer, the 3rd layer, and the 4th layer.

[0028] Next, other printed coils formed on the same substrate are connected to the periphery edge 62 of the printed coil 61 of the 1st layer of W phase, or the current of W phase of a three-phase-circuit alternating current is supplied to it from the outside. This printed coil 61 of the 1st layer is connected with the printed coil 61 of the 2nd layer, the 3rd layer, and the 4th layer through the through hole at the serial.

[0029] The periphery edge 63 of the printed coil 61 of the 4th layer is connected by the following periphery edge 65 and following conductor pattern of the printed coil 64 of the 4th layer of W phase. Furthermore, the periphery edge 66 of the printed coil 64 of the 1st layer of W phase and the periphery edge 68 of the printed coil 67 of the 1st layer of the following W phase are connected by the conductor pattern. The periphery edge 69 of the printed coil 67 of the 1st layer of the W phase is connected by the periphery edge 60 of the printed coil 47 of the 4th layer of U phase and the periphery edge 58 of the printed coil 56 of the 4th phase of V phase, and the conductor pattern.

[0030] Therefore, the current supplied to the printed coil 61 of the 1st layer of W layers flows the printed coil 61 of the 2nd layer, the 3rd layer, and the 4th layer. And it flows from the periphery edge 61 of the printed coil 61 of the 4th layer to the printed coil 64 of the 4th layer as follows of W layers.

[0031] According to the gestalt of operation mentioned above, the surface area of the conductor pattern section which serves as a current path compared with the conventional copper coil with

constituting the moving coil 11 of a linear motor by the printed circuit board of multilayer structure can be doubled [ about / more than ]. Thereby, since the heat dissipation effectiveness of the conductor pattern of a current path can be raised, compared with a copper coil, a current can be passed by one about 5 times the current density of this. Furthermore, since current density can increase, the amount of copper [ used ] is reduced and-izing of the moving coil 11 can be carried out [ lightweight ].

[0032] Next, drawing 4 (A) and (B) are the flat surfaces and important section sectional views of a moving coil 71 by the side of the rotator of the rotary motor of the gestalt of operation of the 2nd of this invention. The moving coil 71 of the gestalt of this 2nd operation consists of multilayer printed boards which consist of a conductor layer which consists of an insulating layer 73 of four layers, printed coils 72b and 76a, etc., as shown in drawing 4 (B), and the conductor layer of the 1st layer is covered with the resist. Moreover, the revolving shaft 91 is being fixed to the center section of the moving coil 71 by press fit, adhesion, and the other mechanical fixed approaches.

[0033] As shown in drawing 4 (A), two printed coils with which the current of U phase of a three-phase-circuit alternating current, V phase, and W phase flows are formed in each class of etching etc., respectively. Two printed coils 72a and 72b of U phase of the 1st layer are formed on the insulating layer 73 of the 1st layer, and printed coil 72a and printed coil 72b are connected to the serial by the conductor pattern 75.

[0034] As for two printed coils 72a and 72b, each inner circumference edge is connected with the inner circumference edge of the printed coils 72a and 72b of the 2nd layer through through holes 74a and 74b. Furthermore, the periphery edge of the printed coils 72a and 72b of the 2nd layer is connected to the periphery edge of the printed coils 72a and 72b of the 3rd layer through a through hole, and the inner circumference edge of the printed coils 72a and 72b of the 3rd layer is connected with the inner circumference edge of the printed coils 72a and 72b of the 4th layer through the through hole.

[0035] Therefore, the current of U phase supplied to the periphery terminal 80 of printed coil 72a of the 4th layer flows printed coil of 3rd layer, 2nd layer, and 1st layer 72a, passes along a conductor pattern 75, flows to printed coil of 1st layer 72b, and flows further to printed coil of 2nd layer, 3rd layer, and 4th layer 72b.

[0036] The printed coils 76a and 76b of the 1st layer to the 4th layer are connected to the serial also for V phase by the through hole, and two printed coils 76a and 76b of V phase of the 1st layer are connected to the serial by through holes 77a and 77b and the conductor pattern (a broken line shows to drawing 4 ) of the 2nd layer. Moreover, the current of V phase of the three-phase alternating current is supplied to the periphery edge of printed coil 76a of V phase of the 4th layer.

[0037] Therefore, the current of U phase supplied to the periphery terminal 81 of printed coil 76a of the 4th layer flows printed coil of 3rd layer, 2nd layer, and 1st layer 76a, passes along the conductor pattern of the 2nd layer, and flows to printed coil of 1st layer 76b. Furthermore, it flows to printed coil of 2nd layer, 3rd layer, and 4th layer 76b.

[0038] The printed coils 78a and 78b of each phase are connected to the serial also for W phase by the through hole, and the printed coils 78a and 78b of W phase of the 1st layer are connected to the serial by the conductor pattern of the 1st layer, through holes 79a and 79b, and the conductor pattern (a broken line shows to drawing 4 ) of the 2nd layer. Moreover, the current of W phase of the three-phase alternating current is supplied to the periphery edge of printed coil 78a of W phase of the 4th layer.

[0039] Furthermore, the periphery edge of the printed coils 72b, 76b, and 78b of U layers, V layers, and W layers of the 4th layer is mutually connected by the conductor pattern. According to the gestalt of this 2nd operation, since a multilayer printed board can constitute the moving coil of a rotary motor, compared with the rotator of a coil, a miniaturization and lightweight-ization are attained, the effectiveness of a motor can also be improved by that cause, and it comes out. Moreover, since a moving coil can be manufactured according to the manufacture process of a multilayer substrate, it becomes possible to reduce a manufacturing cost by automation.

[0040] Although it enabled it to connect the periphery edge of two or more printed coils in the same field top as the field which was mentioned above and in which the conductor layer was made into even number (for example, four layers), and the printed coil was formed with a conductor pattern with the gestalt of the 1st operation, a conductor layer can also be made into odd number when a conductor pattern may be pulled out from the inner circumference edge of a printed coil using a through hole etc.

[0041] Ingredients, such as plastics of not only the glass epoxy group plate of the gestalt of operation but others and a ceramic, can be used for a multilayer substrate. Moreover, the approach of forming a conductor pattern not only by the approach of forming a conductor pattern by etching but by electroplating, chemical plating, etc., the approach of forming a conductor pattern by vacuum evaporation, etc. are sufficient as the manufacture approach of a multilayer substrate.

[0042] Furthermore, the beer which buried the through tube of not only an approach but the insulating layer which uses a through hole by electrolytic plating etc. may be used for the approach of connecting an up-and-down conductor layer through an insulating layer, and you may make it connect it electrically by the other approaches.

[0043] In addition, although it explained the case where a moving coil was constituted from one multilayer substrate, the gestalt of operation mentioned above forms a printed coil in two or more multilayer substrates, respectively, may fix to an adapter plate at one, and may operate the multilayer substrate of these plurality as one moving coil as a whole. When the dimension of a moving coil is large, the cost of a multilayer substrate can be held down by using the multilayer substrate of general-purpose size.

[0044]

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[Translation done.]

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the structure of the moving coil of the gestalt of the 1st operation.

[Drawing 2] It is the explanatory view of the connection method between the layers of a moving coil.

[Drawing 3] It is the explanatory view of the connection method of the printed coil of a three-phase-alternating-current linear motor.

[Drawing 4] Drawing 4 (A) is the top view of the moving coil of the gestalt of the 2nd operation, and drawing 4 (B) is the sectional view.

[Description of Notations]

11 Moving Coil

12 Insulating Layer

13 Printed Coil

14 Multilayer Substrate

71 Moving Coil

72a, 72b Printed coil of U phase

76a, 76b Printed coil of V phase

78a, 78b Printed coil of W phase

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[Translation done.]

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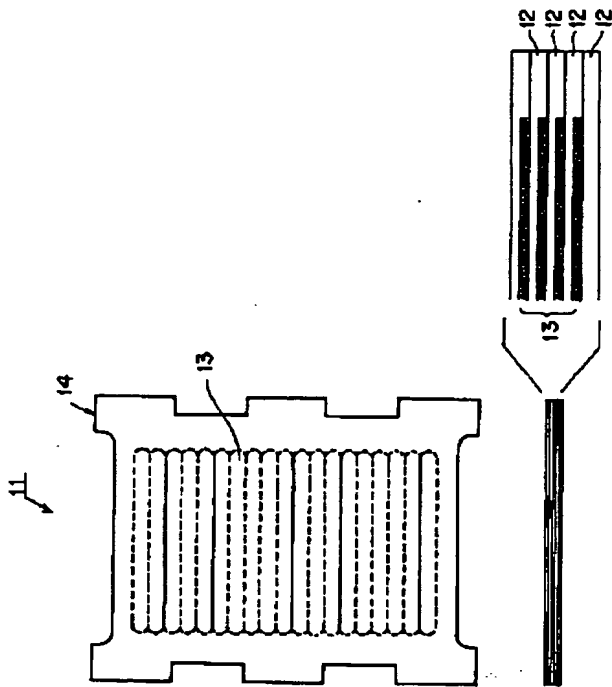
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DRAWINGS

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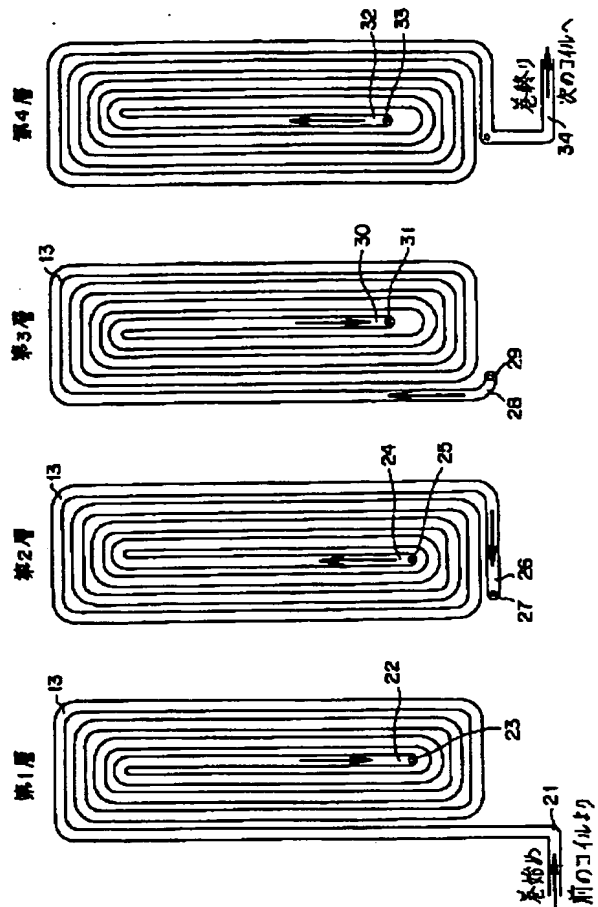
[Drawing 1]

第1の実施の形態の可動コイルの  
構造を示す図



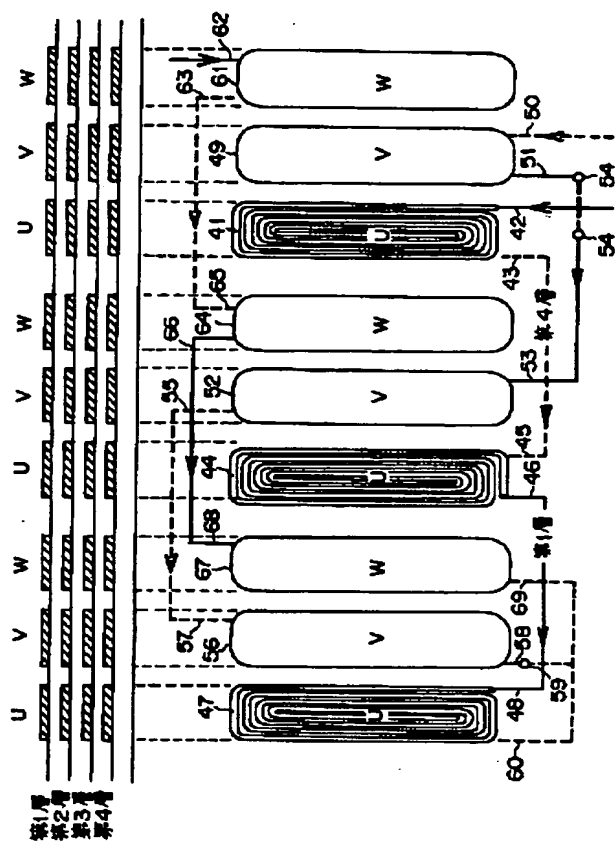
[Drawing 2]

可動コイルの層間の接続方法の説明図



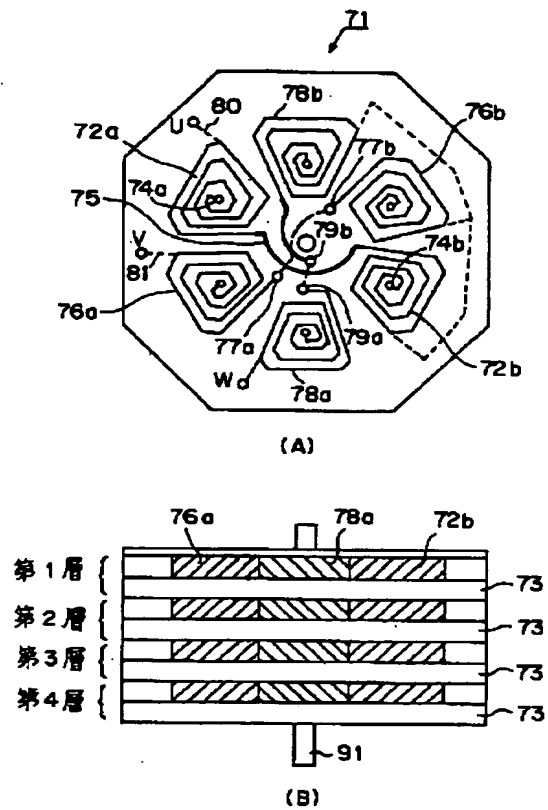
[Drawing 3]

3相交流リニアモータのプリントコイルの接続方法  
の説明図



[Drawing 4]

第2の実施の形態の可動コイルの平面及び  
断面図



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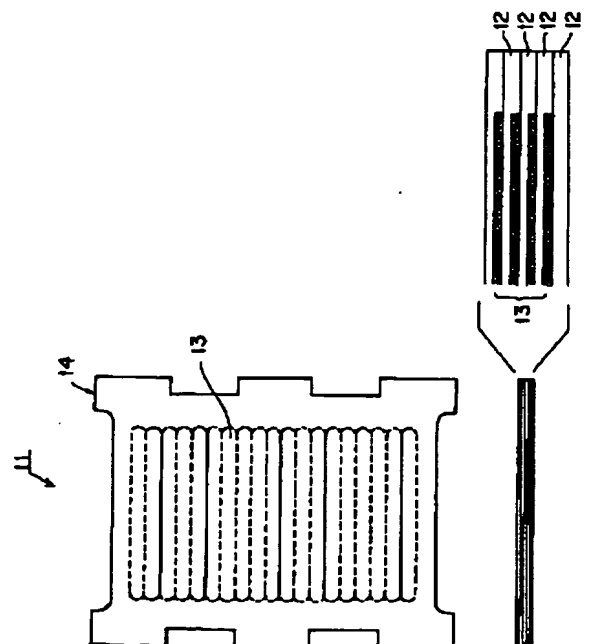
(54) 【発明の名称】 リニアモータの可動コイル及び多層構造の可動コイルを有するモータ

(57) 【要約】

【課題】 リニアモータの可動コイルの放熱効果を高めることである。

【解決手段】 可動コイル1は4層の多層基板14からなり、各層に渦巻き状の導体パターンからなるコイル13が並列に複数形成されている。各層のコイル13は絶縁層12を介してスルーホールにより電気的に接続されている。

第1の実施の形態の可動コイルの  
構造を示す図



(2)

## 【特許請求の範囲】

【請求項 1】巻回された導体パターンからなるコイルが形成された導体層と絶縁層とを積層し、複数の導体層のコイルを電氣的に接続したことを特徴とするリニアモータの可動コイル。

【請求項 2】偶数個の導体層からなり、最上位層と最下位層のコイルの内周端部または最上位層及び最下位層と中間層のコイルの内周端部が絶縁層を介して電氣的に接続されていることを特徴とする請求項 1 記載のリニアモータの可動コイル。

【請求項 3】少なくとも 4 層以上の導体層からなり、最上位層、中間層及び最下位層のコイルの内周端部がそれぞれ絶縁層を介して電氣的に接続され、最上位層及び最下位層のコイルの外周端部を外部入力または同一基板上に形成された他のコイルと接続できるようにしたことを特徴とする請求項 1 または 2 記載のリニアモータの可動コイル。

【請求項 4】前記コイルが同一基板上に複数並列に形成されていることを特徴とする請求項 1, 2 又は 3 記載のリニアモータの可動コイル。

【請求項 5】巻回された導体パターンからなるコイルが形成された少なくとも 3 層以上の導体層と、少なくとも 2 層以上の絶縁層とからなり、複数の導体層のコイルが絶縁層を介して電氣的に接続された多層構造の可動コイルを有するモータ。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は、リニアモータの可動コイル及び多層構造の可動コイルを有するモータに関する。

## 【0002】

【従来の技術】リニアモータは、例えば、可動側に扁平状に巻回されたコイルを複数並列に配置し、固定側にそのコイルと所定の間隔を空けて永久磁石を並列に配置し、コイルに交流電流を供給することで直線運動を行うようになっている。

【0003】可動側のコイルの構造の一例として、例えば、特開平 2000-92812 号公報に、線材を扁平状に巻回して形成したコイルをベース板の上に並列に配列したものが開示されている。

【0004】この発明は、コイルの放熱効果を高めるために、コイルを載せるベース板の中央部を切り欠いたものである。

## 【0005】

【発明が解決しようとする課題】しかしながら、上記の発明も線材を巻いてコイルが作成されているので、電流を流したときの巻線内部での発熱を放散させるのが難しく、コイルの温度上昇を抑えるためにコイルに流す電流を制限する必要があった。

【0006】また、線材を巻いたコイルは重量が重く、

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モータの効率がその分低下するという問題点もあった。本発明の課題は、リニアモータの可動コイルの放熱効果を高めることである。他の課題は、モータの可動コイルを軽量化することである。

## 【0007】

【課題を解決するための手段】請求項 1 記載の発明のリニアモータの可動コイルは、巻回された導体パターンからなるコイルが形成された導体層と絶縁層とを積層し、複数の導体層のコイルを電氣的に接続するように構成する。

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【0008】この発明によれば、各導体層に形成されたコイルからそれぞれ放熱されるので、コイルの放熱面積が大きくなり、コイルに発生する熱を効率良く放散させることができる。また、放熱効率を高めることにより、導体パターンの許容電流密度を大きくできるので可動コイルに使用する銅の量を減らすことができる。これにより、可動コイルを軽量化しリニアモータの効率を改善できる。

【0009】さらに、多層基板の製造プロセスにより可動コイルを製造することができるので、扁平に巻いたコイルを取り付け板に固定する従来の製造方法に比べて製造工程を簡素化できる。

【0010】上記の発明において、偶数個の導体層からなり、最上位層と最下位層のコイルの内周端部または最上位層と中間層及び最下位層と中間層のコイルの内周端部を絶縁層を介して電氣的に接続しても良い。

【0011】このように構成することにより、複数の導体層のコイルの内周端部を電氣的に接続することで所望の巻き数のコイルを実現できる。上記の発明において、

【0012】このように構成することで、同一基板上に形成されたコイルの接続を同じ基板上で行うことができる。請求項 6 記載の発明のモータは、巻回された導体パターンからなるコイルが形成された少なくとも 3 層以上の導体層と、少なくとも 2 層以上の絶縁層とからなり、

【0013】この発明によれば、可動コイルを多層構造とすることで、導体パターンの放熱面積を大きくでき、可動コイルの発熱効果を高めることができる。また、多層基板で構成することで可動コイルを軽量化することができ、それによりモータの効率も改善できる。

## 【0014】

【発明の実施の形態】以下、本発明の実施の形態を図面を参照しながら説明する。図 1 は、第 1 の実施の形態のリニアモータの可動コイル 11 の構造を示す図である。

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(3)

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【0015】この可動コイル11は、ガラスエポキシ等の絶縁層12上にプリントコイル13がエッチングにより形成された多層基板14からなる。プリントコイル13は、渦巻き状にパターンが形成されており、絶縁層12上に複数並列に形成されている。

【0016】可動コイル11は、導体層が4層、絶縁層が最上位層のレジストも含む5層で構成され、1層目から4層目の絶縁層12の上にプリントコイル13が形成されている。

【0017】図2は、多層構造の可動コイル11の層間の接続方法の説明図である。第1層（最上位層）の巻回された導体パターンからなるプリントコイル13の外周端部21は、例えば、リニアモータが3相交流モータであれば、同じ相の他のプリントコイル13と電気的に接続され、その内周端部22にはスルーホール23が形成されている。

【0018】第2層（中間層）の渦巻き状のプリントコイル13の内周端部24にはスルーホール25が形成され、外周端部26にもスルーホール27が形成されている。第2層のプリントコイル13の内周端部24のスルーホール25は、第1層と第2層の間の絶縁層12を貫通して第1層のプリントコイル13の内周端部22のスルーホール23と電気的に接続されている。これにより、第2層のプリントコイル13と第1層のプリントコイル13が直列に接続される。

【0019】第3層の渦巻き状のプリントコイル13の外周端部28にはスルーホール29が形成され、内周端部30にはスルーホール31が形成されている。第3層の外周端部28のスルーホール29は、第3層と第2層の間の絶縁層12を貫通して第2層のスルーホール27と電気的に接続されている。なお、第3層のスルーホール31は、第2層のスルーホール25および第2層のプリントコイルとは絶縁されている。

【0020】これにより、第3層のプリントコイル13と第2層のプリントコイル13が直列に接続される。第4層の渦巻き状のプリントコイル13の内周端部32にはスルーホール33が形成されている。このスルーホール33は、第4層と第3層の間の絶縁層12を貫通して第3層の内周端部30のスルーホール31と電気的に接続されている。これにより、第4層のプリントコイル13と第3層のプリントコイル13は直列に接続される。

【0021】第4層（最下位層）のプリントコイル13の外周端部34は、同一基板上に形成される他のプリントコイル13に接続される。すなわち、第1層のプリントコイル13の内周端部22が第2層のプリントコイル13の内周端部24に接続され、その第2層のプリントコイル13の外周端部26が第3層のプリントコイル13の外周端部28に接続され、さらに、第3層の内周端部30が第4層のプリントコイル13の内周端部32に接続され、全体として4個のプリントコイル13が直列

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に接続される。

【0022】従って、1層当たりのプリントコイル13の巻数を $n$ とすると、4層の場合の可動コイル11全体の巻数は $4n$ となり、層数を増やすことで所望の巻数を得ることができる。

【0023】次に、図3は、リニアモータとして三相交流モータを使用する場合のプリントコイルの接続方法の説明図である。多層基板14には、複数のプリントコイル41、49、61・・・が並列に形成されており、各プリントコイル41、49、61・・・は3相Y形結線で接続され、プリントコイル41、49、61・・・に順にU相、V相、W相の3相交流電流が供給される。

【0024】図3において、実線の矢印は、プリントコイルを接続する第1層の導体パターンを、破線の矢印は第4層の導体パターンを示している。最初にU相のプリントコイルの接続を説明する。U相の第1層のプリントコイル41の外周端部42は、同一基板上に形成されたU相の他のプリントコイルと接続され、または外部から3相交流のU相の電流が供給される。そして、第4層のプリントコイル41の外周端部43は、次のU相の第4層のプリントコイル44の外周端部45と導体パターンにより接続されている。さらに、U相の第1層のプリントコイル44の外周端部46が、次のU相の第1層のプリントコイル47の外周端部48と接続されている。

【0025】従って、U相の第1層のプリントコイル41の外周端部42に供給されたU相の電流は、内周端部のスルーホールを経て第2層のプリントコイル41に流れ、第2層のプリントコイル41の外周端部のスルーホールを経て第3層のプリントコイル41に流れる。さらに、第3層のプリントコイル41の内周端部のスルーホールを経て第4層のプリントコイル41に流れ、その第4層のプリントコイル41の外周端部43から次のU層の第4層のプリントコイル44に流れる。第4層のプリントコイル44に流入した電流は、第3層、第2層及び第1層のプリントコイル44を経て第1層の外周端部46から次のU相の第1層のプリントコイル47に流れる。

【0026】次に、V相の第4層のプリントコイル49の外周端部50には、同一基板上に形成された他のプリントコイルまたは外部から三相交流のV相の電流が供給される。V相の第1層のプリントコイル49の外周端部51は、次のV相の第1層のプリントコイル52の外周端部53と導体パターンにより接続されている。なお、この導体パターンは、上述したU相の導体パターンと交差するので、一部がスルーホール54を介して第3層の導体パターンにより接続されている。V相の第4層のプリントコイル52の外周端部55は、次のV相の第4層のプリント56の外周端部57と導体パターンにより接続されている。そのV相の第1層のプリントコイル56の外周端部58は、スルーホール59を介して導体パ

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ーンにより、U相の第4層のプリントコイル47の外周端部60及びW層の第4層のプリントコイル67の外周端部69と接続されている。

【0027】従って、V相の第4層のプリントコイル49の外周端部50に供給された電流は、内周端部（図示せず）のスルーホールを経て第3層のプリントコイル49に流れ、第3層のプリントコイル49の外周端部のスルーホールを経て第2層のプリントコイル49に流れる。さらに、第2層のプリントコイル49の内周端部のスルーホールを経て第1層のプリントコイル49に流れ、第1層のプリントコイル49の外周端部51から次のV相の第1層のプリントコイル52に流れる。このV相のプリントコイル52に流入した電流は、第2層、第3層及び第4層のプリントコイル52を経て第4層のプリントコイル52の外周端部55から次のV相の第4層のプリントコイル56に流れる。

【0028】次に、W相の第1層のプリントコイル61の外周端部62には、同一基板上に形成された他のプリントコイルが接続され、あるいは外部から3相交流のW相の電流が供給される。この第1層のプリントコイル61はスルーホールを介して第2層、第3層及び第4層のプリントコイル61と直列に接続されている。

【0029】第4層のプリントコイル61の外周端部63は、次のW相の第4層のプリントコイル64の外周端部65と導体パターンにより接続されている。さらに、W相の第1層のプリントコイル64の外周端部66と次のW相の第1層のプリントコイル67の外周端部68とが導体パターンにより接続されている。そのW相の第1層のプリントコイル67の外周端部69は、U相の第4層のプリントコイル47の外周端部60及びV相の第4層のプリントコイル56の外周端部58と導体パターンにより接続されている。

【0030】従って、W層の第1層のプリントコイル61に供給された電流は、第2層、第3層及び第4層のプリントコイル61を流れる。そして、第4層のプリントコイル61の外周端部61から次のW層の第4層のプリントコイル64に流れる。

【0031】上述した実施の形態によれば、リニアモータの可動コイル11を多層構造のプリント基板により構成することで、従来の銅巻線に比べ電流通路となる導体パターン部の表面積を約2倍以上にすることができる。これにより、電流通路の導体パターンの放熱効率を高めることができるので、銅巻線と比べて約5倍の電流密度で電流を流すことができる。さらに、電流密度が増加できるので、銅の使用量を減らし可動コイル11を軽量化できる。

【0032】次に、図4（A）、（B）は、本発明の第2の実施の形態の回転モータの回転子側の可動コイル71の平面及び要部断面図である。この第2の実施の形態の可動コイル71は、図4（B）に示すように4層の絶

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縁層73とプリントコイル72b、76a等からなる導体層とからなる多層プリント基板で構成され、第1層の導体層はレジストにより覆われている。また、可動コイル71の中央部には回転軸91が圧入、接着、その他の機械的な固定方法で固定されている。

【0033】各層には、図4（A）に示すように、3相交流のU相、V相、W相の電流が流れるプリントコイルがエッチング等によりそれぞれ2個形成されている。第1層のU相の2個のプリントコイル72a、72bは、  
10 第1層の絶縁層73の上に形成されており、プリントコイル72aとプリントコイル72bは導体パターン75により直列に接続されている。

【0034】2個のプリントコイル72a、72bは、それぞれの内周端部がスルーホール74a、74bを介して第2層のプリントコイル72a、72bの内周端部と接続されている。さらに、第2層のプリントコイル72a、72bの外周端部がスルーホールを介して第3層のプリントコイル72a、72bの外周端部に接続され、第3層のプリントコイル72a、72bの内周端部がスルーホールを介して第4層のプリントコイル72  
20 a、72bの内周端部と接続されている。

【0035】従って、第4層のプリントコイル72aの外周端子80に供給されるU相の電流は、第3層、第2層、第1層のプリントコイル72aを流れ、導体パターン75を通り、第1層のプリントコイル72bに流れ、さらに、第2層、第3層及び第4層のプリントコイル72bに流れる。

【0036】V相も第1層から第4層のプリントコイル76a、76bがスルーホールにより直列に接続されており、第1層のV相の2個のプリントコイル76a、76bがスルーホール77a、77bと第2層の導体パターン（図4に破線で示す）とにより直列に接続されている。また、第4層のV相のプリントコイル76aの外周端部には三相交流のV相の電流が供給される。

【0037】従って、第4層のプリントコイル76aの外周端子81に供給されるU相の電流は、第3層、第2層、第1層のプリントコイル76aを流れ、第2層の導体パターンを通り、第1層のプリントコイル76bに流れる。さらに、第2層、第3層及び第4層のプリントコ  
40 イル76bに流れる。

【0038】W相も各相のプリントコイル78a、78bがスルーホールにより直列に接続されており、第1層のW相のプリントコイル78a、78bが、第1層の導体パターン、スルーホール79a、79b、及び第2層の導体パターン（図4に破線で示す）により直列に接続されている。また、第4層のW相のプリントコイル78aの外周端部には、三相交流のW相の電流が供給される。

【0039】さらに、第4層のU層、V層、W層のプリントコイル72b、76b、78bの外周端部は導体パ  
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ターンにより互いに接続されている。この第2の実施の形態によれば、回転モータの可動コイルを多層プリント基板により構成できるので、巻線の回転子に比べて、小型化、軽量化が可能となり、それによりモータの効率も改善でき得る。また、可動コイルの製造を多層基板の製造プロセスにより行うことができるので、自動化により製造コストを低減することが可能となる。

【0040】上述した第1の実施の形態では、導体層を偶数（例えば、4層）にして、プリントコイルが形成された面と同一面上で複数のプリントコイルの外周端部を導体パターンにより接続できるようにしたが、プリントコイルの内周端部からスルーホール等を使用して導体パターンを引き出しても良い場合には、導体層を奇数にすることもできる。

【0041】多層基板は、実施の形態のガラスエポキシ基板に限らず、その他のプラスチック、セラミック等の材料を使用することができる。また、多層基板の製造方法は、導体パターンをエッチングにより形成する方法に限らず、電気メッキ、化学メッキ等により導体パターンを形成する方法、蒸着により導体パターンを形成する方法等でも良い。

【0042】さらに、絶縁層を介して上下の導体層を接続する方法は、スルーホールを用いる方法に限らず、絶縁層の貫通孔を電解メッキ等により埋めたビアを用いても良いし、その他の方法で電氣的に接続するようにしても良い。

【0043】なお、上述した実施の形態は、可動コイルを1枚の多層基板で構成する場合について説明したが、複数の多層基板にそれぞれプリントコイルを形成し、それら複数の多層基板を取り付け板に一体に固定して、全体として1つの可動コイルとして機能させても良い。可動コイルの外形寸法が大きい場合には、汎用のサイズの多層基板を使用することで多層基板のコストを抑えることができる。

【0044】

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【発明の効果】本発明によれば、線材を重ね巻きした従来の可動コイルに比べて電流の流れる導体パターンの放熱面積を大きくして放熱効果を高めることができる。また、放熱効果を高めることにより、導体パターンの許容電流密度を大きくできるので、所望のモータ出力を得るために可動コイルに使用する銅の量を減らすことができる。これにより、可動コイルを軽量化しモータの効率を改善できる。また、可動コイルの製造を多層基板の製造プロセスで行うことができるので、自動化により製造コストを低減できる。さらに、最上位層と最下位層のコイルの内周端部を絶縁層を介し、あるいは中間の導体層及び絶縁層を介して接続することで、最上位層及び最下位層のコイルの外周端部を直接他のコイルの外周端部と接続することができる。これにより、コイルと外部入力との接続、あるいは導体パターンからなるコイルどうしの接続を、コイルが形成されている面と同一面上で行うことができ、コイルを接続するためのスルーホール等の数を少なくして製造コストを低減できる。

【図面の簡単な説明】

【図1】第1の実施の形態の可動コイルの構造を示す図である。

【図2】可動コイルの層間の接続方法の説明図である。

【図3】三相交流リニアモータのプリントコイルの接続方法の説明図である。

【図4】図4（A）は、第2の実施の形態の可動コイルの平面図、図4（B）はその断面図である。

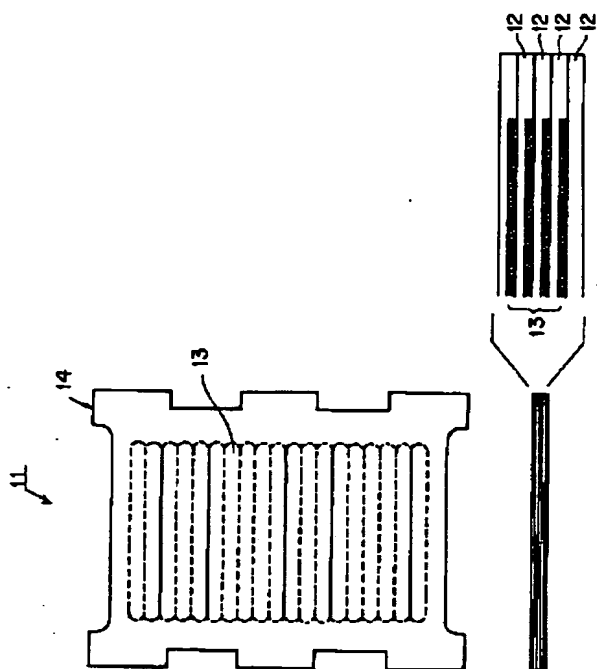
【符号の説明】

- |             |            |
|-------------|------------|
| 1 1         | 可動コイル      |
| 1 2         | 絶縁層        |
| 1 3         | プリントコイル    |
| 1 4         | 多層基板       |
| 7 1         | 可動コイル      |
| 7 2 a、7 2 b | U相のプリントコイル |
| 7 6 a、7 6 b | V相のプリントコイル |
| 7 8 a、7 8 b | W相のプリントコイル |

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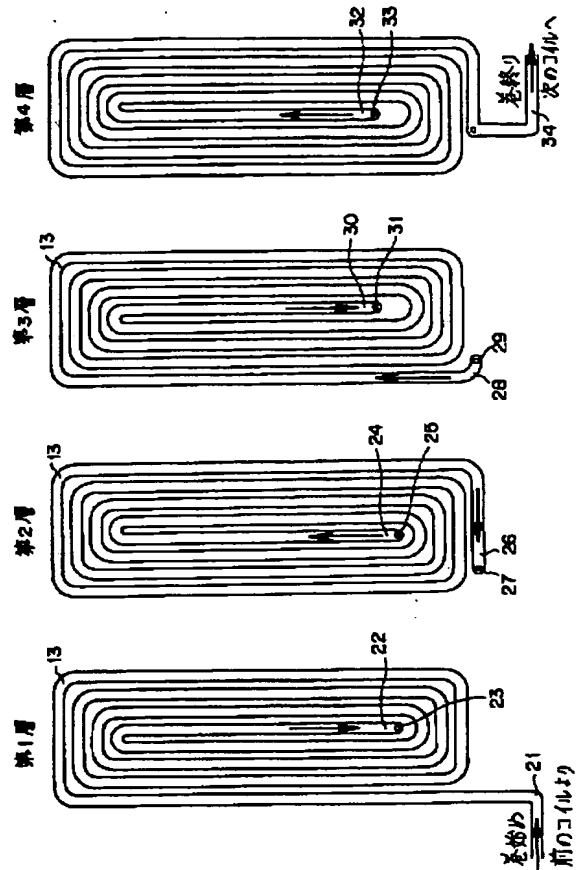
【図1】

第1の実施の形態の可動コイルの  
構造を示す図



【図2】

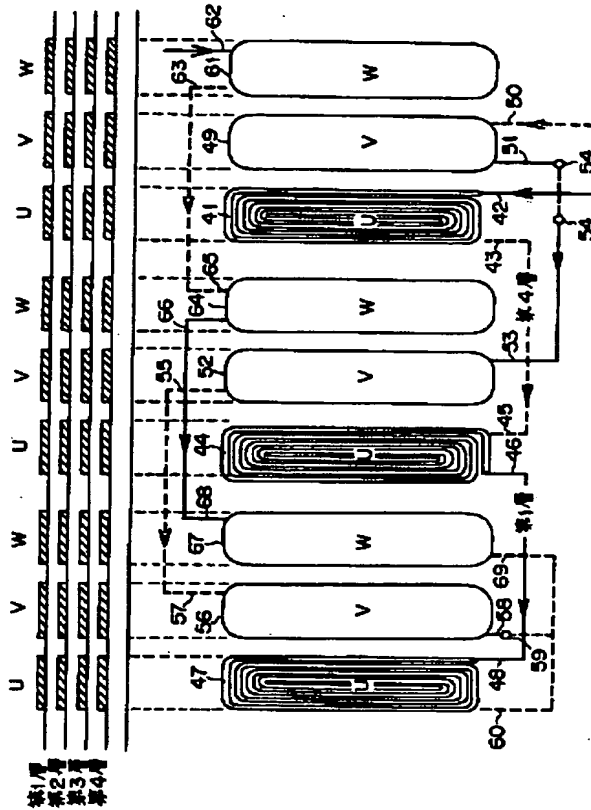
可動コイルの層間の接続方法の説明図



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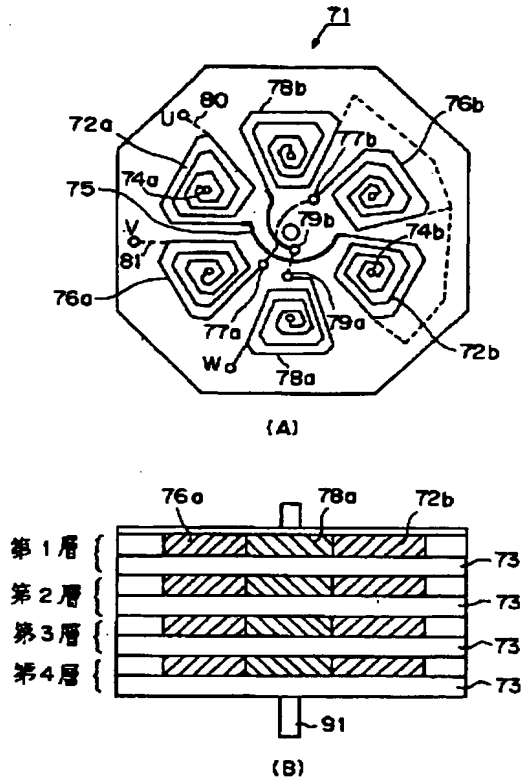
【図3】

3相交流リアモータのプリントコイルの接続方法  
の説明図



【図4】

第2の実施の形態の可動コイルの平面及び  
断面図



フロントページの続き

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